EFFICIENCY ASSESSMENT OF PLANT-BASED NATURAL COAGULANTS IN RAW WATER TREATMENT

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ABSTRACT

Coagulants play a very crucial role in the treatment of potable water, especially in the consumption of drinking water for human kind. In this study, some natural coagulants have been explained for the coagulation process. Natural coagulants namely, Dolichol lablab, Cicer arietinum bean used as natural coagulant in this study. The jar test was per-formed with different dosages of natural coagulants and chemical coagulants i.e., alum The chemical coagulant has the problem of inorganic sludge, because it creates the issue of disposing it. While natural coagulant also creates sludge, this sludge is organic in nature, so it can be used as fertilizers, if they are free from toxic contaminants.

Keywords: *Dolichol lablab, Cicer arietinum, Aluminum sulphate, Jar test.*

1.0 INTRODUCTION

All life on Earth depends on water, which is a major component of the biosphere. Because of this, drinking and using surface water is not aesthetically pleasing. The World Health Organization (WHO) has established a recommendation value of 5 Nephelometric Turbidity Units (NTU) for residual turbidity in drinking water. As a result, water treatment is required to lower turbidity. Coagulation is one of the crucial steps in the treatment regimen. Most particulate matter cannot settle by gravity and their sizes are so small that they pass through the pores of most common filtration media. The use of chemical coagulants like aluminium salts has been linked in recent studies to a number of serious negative effects, including Alzheimer's disease linked to high aluminium residuals in treated water, excessive sludge production during water treatment, and significant changes in water chemistry due to reactions with the OH and alkalinity of water. Natural coagulants have been developed in view of this critical issue. Numerous studies on natural substitutes for materials used in the coagulation phase of water treatment have been conducted. A recent study on the use of natural coagulants for surface water treatment shows that Cicer Arietinum (CA), a natural coagulant, can reduce water turbidity by up to 87 percent. Importing chemicals for the purification of water is expensive for developing nations. Some conventional chemicals are utilized at various stages of the treatment process.

The history of the use of natural coagulants is long. Natural organic polymers have been used for more than 2000 years in India, Africa, and China as effective co-agulants and coagulant aids at high water turbidity. Re-search works by several researchers confirmed that natural coagulants are both economical and efficient. These coagulants are classified into inorganic, syn-thetic organic polymers, and natural coagulants. Several studies have been done on natural coagulants produced or extracted from plants, animals, or microorganisms. Natural coagulants may be manufactured from plant seeds, leaves, and roots. These natural organic polymers are interesting because, comparative to the use of syn-thetic organic polymers containing acryl amide monomers, there is no human health

danger and the cost of these natural coagulants would be less expensive.

Statement of the Problem

In order to make the water suitable for the intended end use, water treatment involves removing pollutants and unwanted components or reducing their concentration. Human health depends on this procedure, which also enables drinking and irrigation use benefits. However, there are significant restrictions on the use of chemical coagulants due to their drawbacks, which include; an increase in the pH of treated water, the cost of the coagulants. The main objective of this project is to treating the water naturally using natural products of plants and comparing efficiencies with the chemical coagulants like aluminum.

The Project Objectives

- To analyze the physical-chemical parameters of water samples.
- To evaluate the optimum dosage of natural coagulant for water samples.
- To compare the treatment efficiencies of natural coagulants that of alum.

2.0 LITERATURE REVIEW

[1] Rajesh K Kaushal and Hemanth Goyal (2019) Conducted an experiment for the treatment of waste water using natural coagulant. Municipal waste water and dairy plant waste water are used in this study. Main natural coagulants are Moringa Oleifera (Drum stick) and Okra (Ladyfinger) plants. After the treatment of 2 samples of water with the coagulants taken, the results show that there is a reduction in percentage of various polluting parameters like COD, BOD, Turbidity, Hardness, TSS and TDS etc.

[2] Devanandh R and Dinesh M et al (2020) Conducted a comparative study of bio materials as a coagulant for waste water treatment. The main natural coagulants used are neem leaf powder, orange peel powder, banana pith juice. New coagulant process technique such as composite polymerization and impregnation method can be incorporated in producing coagulant with enhanced capability. This review highlighted that many potential advantages in using natural coagulant from various sources of plant, animals or biomass.

[3] Sandly Maurya and AchleshDaveray (2018) Conducted an experiment for plant based natural coagulants for municipal waste water treatment. The coagulants used in this experiment are Banana peel powder, Banana stem juice and papaya seed. Main experiment conducted to analyze the characteristics of municipal sewage water are turbidity, COD, TSS. And the main advantages noted on this experiment is that, all the natural coagulants tested in the study did not change the PH of the waste water. By analyzing the result, the banana peel powder was found to be more effective while banana stem juice has poor coagulation activity.

[4] Diaz, et al. (1999) A synthetic water created to match the drinking water given to the city of Maracaibo was used to test the capacity of two plant materials, Cactus latifaria and the seeds of Prosopis juliflora, to operate as natural coagulants. Kaolin was used to add turbidity. Using measurements from a common jar test, the two materials' capacity to coagulate was evaluated. With both high (100-200 NTU) and low (30-40 NTU) beginning

turbidities, both materials provided equivalent turbidity removals and were able to create final waters whose turbidity was near to the necessary standard of 5NTU. This performance was comparable to what earlier workers utilizing Moringa oleifera extracts had accomplished. It was discovered that the ideal coagulant dose was lower than that for aluminium sulphate. When raw vegetable solids were treated with solvents, coagulants were sometimes formed that were distinct from the raw materials, which indicated that non-polar components might be involved in the coagulation process.

3.0 METHODOLOGY

Materials used:

Natural coagulants

- Dolichol lablab (beans),
- Cicer arietinum (dal) seeds.

Chemical coagulants

Alum

Jar Test Apparatus

Theoretical Background

Water must be examined with various different physic-chemical requirements. Selection of guidelines for examining of water is merely depends upon for what purpose we are going to use that water and what range we require its character and healthiness. Some physical examination should be carried for testing of its physical characteristics such as temperature, color, odor, PH, turbidity etc., while chemical analysis should be executed for its Biochemical Oxygen Demand, Chemical Oxygen Demand, dissolved oxygen, alkalinity and other parameters.

Classification of Coagulants:

1) Natural Coagulant
2) Chemical Coagulant

Natural coagulant: These coagulants occurring from the seeds, leaves and branch of the plants/ tree are considered as a natural coagulant.

Chemical coagulant: chemical used as coagulant either be salts or polymer in nature. The polymer may be either anion (negatively charged), cationic (positively charged) or non-ionic (neutrally charged). Widely used chemical coagulants in the water treatment process is generally alum which is most popular coagulant because it has less impact of scaling and corrosion in the water distribution system.

Natural Coagulants:

i. **Dolichol lablab (beans),**
ii. **Cicer arietinum (dal) seeds.**

They were air dried and finely powdered. The fine powder was then used as coagulant at different doses to clean the water.

Figure 1: Dolicho lablab (beans) and Cicer arietinum (dal)

Chemical Coagulant:

ALUM – The aluminium sulphate [Al2(SO4)3.18H2O] is used in this study.

The solutions were mixed slowly with glass rods and left it to completely mix.

Pre-Experimental Run

Variables that are affected by temperature such as pH, viscosity, density, and floc volume concentration which makes it important to maintain and control the temperature for accurate result. The turbid water samples were kept constant at room temperature for duration of experiment. Samples were prepared at room temperature for the temperature to ensure that the experiment would run smoothly and the results can be measured with an acceptable degree of precision.

Various dosages of different coagulants were prepared as follows:

a. Dolicho lablab dosage: The 500ml volume of raw water samples were used at different Dolicho lablab dosages and percentage of turbidity removed is observed.
b. Cicer arietinum dosage: The 500ml volume of raw water samples were used at different Cicer arietinum dosages and percentage of turbidity removed is observed.
c. Alum: The 500ml volume of raw water samples were used at different Alum dosages and percentage of turbidity removed is observed.

4.0 RESULTS AND DISCUSSIONS

Table 1: pH

Sample Description	pH
Sample 1	7.54
Sample 2	7.36
Sample 3	7.31
Sample 4	7.8
Sample 5	7.5
Sample 6	7.8

Figure 2: Testing pH

Table 2: Alkalinity

Sample Description	Alkalinity
Sample 1	No
Sample 2	No
Sample 3	No
Sample 4	No
Sample 5	No
Sample 6	No

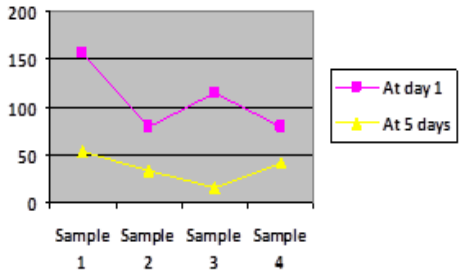
Table 3: Acidity

Sample Description	Acidity
Sample 1	75 mg/L
Sample 2	95 mg/L
Sample 3	75 mg/L
Sample 4	65 mg/L
Sample 5	41 mg/L
Sample 6	41 mg/L

Figure 3: Testing Acidity

Table 4: Chemical Oxygen demand

COD values for day1	COD values for 5 days	Dilution Factor
156.67 mg/L	53.856 mg/L	1:40
78.33 mg/L	34.272 mg/L	1:40
115.2 mg/L	16.64 mg/L	1:50
78.33 mg/L	42.1050 mg/L	1:50

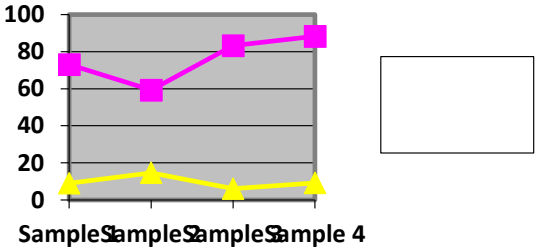


Graph 1: Comparison of COD for day1 and 5 days

Figure 4: COD

Table 5: Biological Oxygen Demand/Dissolved Oxygen

DO @ Day 1	DO @ 5 days	Dilution ratio
73.08 mg/L	8.932 mg/L	1:40
59.276 mg/L	14.616 mg/L	1:40
83.23 mg/L	6.09 mg/L	1:50
88.305 mg/L	9.135 mg/L	1:50



Graph 2: Comparison of DO for day1 and 5days

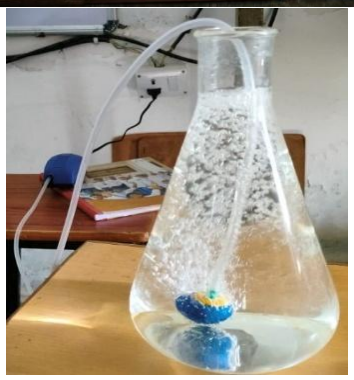


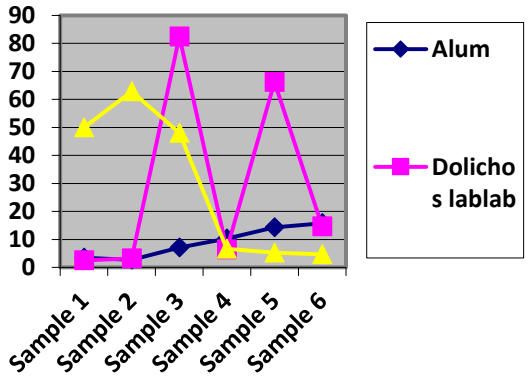
Figure 5: BOD/DO

Figure 6: Incubation of samples for BOD/DO

Figure 7: BOD/DO

Table 6: Turbidity and Coagulation

Description of sample	Initial turbidity of sample (NTU)	Turbidity removal of Alum (NTU)	Turbidity removal of Dolichos lablab (NTU)	Turbidity of Cicer arietinum (NTU)
Sample 1	209	3.4	2.48	50
Sample 2	209	2.7	3.14	62.87
Sample 3	209	7.13	82.46	48
Sample 4	209	10.3	6.42	6.65
Sample 5	209	14.34	66.25	5.1
Sample 6	209	15.75	14.62	4.64

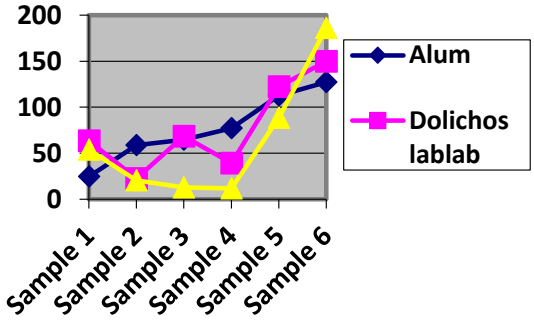


Graph 3: Comparison of Turbidity

Figure 8: Coagulation

Table 7: COD after Coagulation

Description of sample	COD of Alum (mg/L or ppm)	COD of Dolichos lablab (mg/L or ppm)	COD of Cicer arietinum (mg/L or ppm)
Sample 1	24.5	63.64	53.85
Sample 2	58.7	22.5	20.56
Sample 3	64.6	68.5	12.72
Sample 4	77.3	39.1	11.75
Sample 5	112.6	122.4	88.13
Sample 6	127.2	149.8	186.048



Graph 4: Comparison of COD after Coagulation

Table 8: Comparison with IS code

Water Characteristics	Limits as per IS code	Raw water	Chemical Coagulants	Natural Coagulant	
				Cicer arietinum (60 %)	Dolichos lablab (10 %)
pH	6.5 – 8.5	7.8	7.2	7.5	6.8
Alkalinity	200 – 600 ppm	No alkalinity	No alkalinity	No alkalinity	No alkalinity
Acidity	10 – 50 ppm	86ppm	60 ppm	36 ppm	40 ppm
TDS	500 – 2000 ppm	825	390	135	977
COD	20 – 1000 ppm	78.33 ppm	24.5 ppm	20.56	22.5
Hardness	Upto	50 ppm	48 ppm	52 ppm	58 ppm

	60 ppm		(Slightly hard)	(Slightly hard)	(Slightly hard)
Chlorine	250 – 1000 ppm	Absent	Absent	Absent	Absent
Conductivity	≤ 3 µ mhos/cm	1.043 µ mhos/cm	4.76 µ mhos/cm	1.825 µ mhos/cm	1.414 µ mhos/cm

CONCLUSION:

- *Dolichos lablab, Cicer arietinum, Alum is used for the study. Usage of some locally available natural coagulants, for example, Dolichos lablab and Cicer arietinum, showed significant improvement in removing turbidity from raw water compared to Alum for same dosage.*
- *The given coagulants i.e., alum, Cicer arietinum, Dolichos lablab shows higher turbidity removal efficiency and the natural coagulants showing substantially treatment efficiencies when compared with alum, Dolichos lablab its efficiency comes even more that alum.*
- *And also compared to chemical coagulant alum and natural coagulants i.e., Cicer arietinum and Dolichos lablab. The removal of physical-chemical parameters i.e., pH, Acidity, TDS, COD, Hardness, Chlorine and Conductivity of water samples are more effective in natural coagulants compared to chemical coagulant.*

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